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PERFORMANCE OF DIRECT-SEEDED RICE (*ORYZA SATIVA* L.) CULTIVARS AS EFFECTED BY DIFFERENT CROP ESTABLISHMENT METHODS UNDER MID HILL CONDITIONS OF NAGALAND

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ABSTRACT

The response of direct-seeded rice (*Oryza sativa* L.) cultivars towards different crop establishment methods was studied at School of Agricultural Sciences and Rural Development, NU, Medziphema Campus, Nagaland during the *kharif* season of 2009 and 2010.In this experiment, two crop establishment methods*viz.*, line sowing and broadcasting and four local direct-seeded rice cultivars *viz.*,'*Kezie*', '*Chongloiman*', '*Leikhumo*' and '*Kotsala*'were evaluated for growth and yield performance of rice. The results showed that line sowing was found superior over broadcasting in recording higher LAI (leaf area index), plant height, tillers/m^2, dry matter accumulation, CGR (crop growth rate), panicles/m^2, filled grains/panicle and1000-grain weight and ultimately recorded higher grain and straw yield. The cultivars '*Chongloiman*' and '*Kezie*' recorded the highest dry matter accumulation and number of tillers/m^2 respectively. Also, significantly higher LAI, CGR, Panicles/m^2, filled grains/panicle and grain yield were recorded by the cultivars '*Chongloiman*' and '*Kezie*', which were comparable to each other. Whereas, the highest plant height, unfilled grains/panicle, grain sterility percent and straw yield was recorded by the cultivars '*Leikhumo*' and '*Kotsala*', which were at par. All the four cultivars recorded the lowest cost of cultivation under line sowing. The highest gross return and net return/ha and also the highest BCR (benefit cost ratio) were recorded by the cultivar '*Chongloiman'* under line sowing.

KEYWORDS: Direct-Seeded Rice, Crop Establishment, Cultivars, Leaf Area Index, Crop Growth Rate, Benefit Cost Ratio

INTRODUCTION

Establishment a good crop stand is a pre-requisite for attaining high crop yields. Sowing method is a very important factor that determines the crop stand and ultimately the crop yield. The way a crop is grown also gives the crop subsequent advantage for weed control in the form of greater selectivity between crop and weed during subsequent weeding. In broadcasting method the seeds fall at different depths resulting in uneven crop stand, which ultimately affects the crop yield (Reddy and Reddi, 2002). Drilling the seeds in lines is an improved method over that of broadcasting in which the seed rate is generally reduced**.** Sowing the crop in lines facilitates uniform depth and spacing resulting in fast and uniform crop emergence and establishment leading to higher crop yields. Thus, selection of proper sowing method is necessary to ensure proper plant population, synchronization of tillering, flowering; maturity and reaping bumper yield of rice. The characteristics of the cultivar such as morphology and growth rate can have a significant effect on crop

development and ultimately its yield potential. The morphological and physiological traits of a strongly competitive crop will enable it to capture resources from weeds and utilize resources more efficiently (Lemerle*et al.,* 2001). Correct choice of cultivar may also be essential in maintaining crop quality, contrary to complex crop management schemes, requiring specialized skills and training, improved varieties have a high potential for adoption by farmers. Therefore, the present investigation was initiated to study the differences in growth and yield potential of local direct-seeded rice cultivars as affected by different crop establishment methods under mid hill conditions of Nagaland.

MATERIALS AND METHODS

A study was conducted during *kharif* season of 2009 and 2010 in the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, Nagaland. The soil of the experimental plot was clayey loam and well drained, strongly acidic in reaction (pH 5.0), low in available nitrogen, medium in available phosphorous and available potassium and had high organic carbon content. The experiment plot was located at an altitude of 310 m above mean sea level with the geographical location at 25˚ 45' 45" N latitude and 95° 53' 04" E longitude. Layout system of the trial was split plot design replicated four times with two different crop establishment methods*viz.,* line sowing and broadcasting as main plot treatments and four local direct-seeded rice cultivars *viz.,*'*Kezie*', '*Chongloiman*', '*Leikhumo*' and '*Kotsala*' as sub-plot treatments. All the four rice cultivars used in the experiment were local direct-seeded cultivars grown in and around Medziphema village. '*Chongloiman*', '*Leikhumo*' and '*Kotsala*' were tall cultivars and had long maturity duration, whereas '*Kezie*' was a semi-dwarf cultivar with medium maturity duration. Field preparation was done during the last week of April and May respectively with tractor drawn plough during both the years. Well decomposed FYM @ 10 t/ha was uniformly broadcasted over the field and incorporated during final land preparation and NPK @ 40: 20: 20 kg/ha in the form of Urea, Single Super Phosphate and Murite of Potash were applied in all the experimental plots. All the four cultivars were sown during the first week of June with a seed rate of 100kg/ha and 50kg/ha for broadcasting and line sowing respectively. For line sowing the seeds were sown in furrows at 20 cm inter-row and 10 cm inter-plant distance. Under broadcast method the seeds were broadcasted over the seedbeds then covered with soil using local plough and rake.For weed control butachlor@1.5kg/ha was applied 3 DAS (days after sowing), which was followed by one hand, weeding at 40 DAS. All other agronomic and cultural practices were kept standard and uniform for all treatments. The cultivar '*Kezie*' was harvested during the first week of October while the other three cultivars were harvested during the second week of October. Data on crop growth and yield attributes *viz.,* LAI, plant height, tillers/m^2, dry matter accumulation/m^2, CGR, panicles/m^2, filled and unfilled grains/panicle, grain sterility percent, 1000 grain weight and grain yield and straw yield were recorded to study the response of the different treatments. Data collected were statistically analyzed by applying the technique of analysis of variance as described by Gomez and Gomez (2010). The significant differences were tested by 'F' test. Critical difference of different groups of treatments and their interactions at 5 per cent probability level were calculated whenever 'F' test was significance.

RESULTS & DISCUSSIONS

Growth Attributes

Effect of Crop Establishment Methods

Crop establishment methods were found to exhibit significant differences with respect to crop growth attributes (Table.1). Significantly higher LAI was recorded by line sowing as compared to broadcasting. Early establishment of a uniform crop stand under line sowing may have resulted in better competition with weeds for space, light, nutrient and

water inducing better leaf growth, which along with optimum plant density may have resulted in optimum LAI. Whereas, uneven crop stand observed under broadcasting may have resulted in lower LAI. In broadcast-seeded rice, plant stand is poorer as compared to drill line sown crop (Singh and Bhattacharyya, 1989). Leaf size is influenced by light, moisture regime and available plant nutrients in the soil (Reddy and Reddi, 2002). Line sowing was also found to recorded significantly higher plant height and number of tillers as compared to broadcasting. The increased/optimum plant density under line sowing may be attributed for higher plant height and tillers. Roy *et al.* (2009) also reported that the highest number of effective tillers/hill was recorded from direct seeding whereas, broadcasting produced the lowest number of effective tillers/ hill. Gogoi (1997) also observed an increase in plant height with the increase in planting density. Significantly higher dry matter accumulation andCGRwere recorded under line sowing as compared to broadcasting. Higher LAI, plant height and number of tillers observed under line sowing may be attributed for higher dry matter accumulation and CGR. Also the increase in photosynthetic area may have resulted in higher dry matter production and ultimately higher CGR. As LAI increases, light interception is more resulting in higher dry matter production (Reddy and Reddi, 2002).

Effect of Cultivars

Significant differences in crop growth parameters *viz.*, LAI, plant height, number of tillers, dry matter accumulation and CGR were recorded among the four cultivars (Table.1). The cultivars '*Kezie*' and '*Chongloiman*' were at par with each other and recorded significantly higher LAI. '*Kezie*' was found to record significantly higher LAI as compared to both '*Leikhumo*' and '*Kotsala*' whereas, '*Chongloiman*' was found to record significantly higher LAI over the cultivar '*Leikhumo*'. Better vegetative crop growth exhibited by '*Kezie*' and '*Chongloiman'*early in the cropping period as a result of better utilization of growth resources like light, space, water and nutrients may have resulted in better leaf area development. Solar radiation, temperature, mineral nutrients and water status are important factors that determine the size of the leaf. The potential leaf size that can be reached depends on solar radiation and temperature but its realization depends on nutrient supply (Reddy and Reddi, 2002).'*Leikhumo*' and '*Kotsala*' were at par with each other and recorded significantly higher plant heightover both the cultivars '*Kezie*' and '*Chongloiman*'. '*Chongloiman*' was also found to record significantly higher plant height as compared to '*Kezie*'. This may be due to the fact that '*Leikhumo*', '*Kotsala*', and '*Chongloiman*' were tall cultivars whereas; '*Kezie*' was semi-dwarf in nature. '*Kezie*' recorded the highest number of tillersas compared to the rest of the cultivars, which may be due to higher LAI and better uptake of growth resources. Significantly highestdry matter accumulationwas recorded by the cultivar '*Chongloiman*' over the rest of the cultivars. Higher LAI recorded by '*Chongloiman'*may be attributed for the higher dry matter accumulation as recorded by the cultivar.Caton*et al.*, (2003) also reported that the leaf area was the most important factor affecting the dry matter production of rice. CGR was also found to be significantly higher for the cultivars '*Kezie*' and '*Chongloiman*'which may be due to high tillering associated with '*Kezie*' and highdry matter accumulation associated with '*Chongloiman*'.

Yield and Yield Attributes

Effect of Crop Establishment Methods

A perusal of the data presented in Table. 2 shows that the two crop establishment methods exhibited significant differences in crop yield and yield attributes. Between the two crop establishment methods, line sowing produced significantly more number of panicles/m^2 compared to broadcasting. Higher tillering exhibited by the crop as a result of better crop growth under line sowing may have resulted in higher number of panicles/m^2. Johnson *et al.*, (1998) found that

higher tiller production increases the ability of a rice plant to produce more panicles. Number of filled grains/panicle and 1000 grain weight was also found to follow the same trend where, significantly higher values of both parameters were recorded by line sowing as compared to broadcasting. This may be due to higher uptake of growth resources by the crop under line sowing. Higher nutrient availability subsequently results in better source to sink conversion, which enhances higher number of grains per panicle (Vijayakumar*et al.*, 2006). Roy *et al.* (2009) also reported that broadcasting produced the lowest number of filled grains/panicle and 1000-grain weight. Planting methods did not show any significant differences with respect to grain sterility percent and 1000-grain weight during both the years. The highest grain yield and straw yield was recorded under line sowing owing to better expression of growth and yield attributes as discussed above.

Effect of Cultivars

Significant variations in crop yield and yield attributes were observed among the four cultivars tested (Table. 2). '*Kezie*' recorded the highest number of panicles/m^2, which was significantly higher in comparison to '*Leikhumo*' and '*Kotsala*' and at par with'*Chongloiman*'. Higher number of panicles/m^2 recorded by '*Kezie*' may be due to higher tillering as observed under the cultivar. Tillering capacity is one of the most important characters determining yield potential, as it is closely related with the number of panicle per unit area (Zou*et al.*, 1991). Significantly higher number of filled grains/panicle and grain yield was recorded by '*Chongloiman*'as compared '*Leikhumo*' and '*Kotsala*' whereas, '*Kezie'*also recorded significantly higher filled grains/panicle and grain yield over '*Leikhumo*'.The highest number of unfilled grains/panicle and sterility percent of grainswas recorded by'*Leikhumo*' and '*Kotsala*' which were at par with each other whereas significantly lower number of unfilled grains/panicle and grain percent sterility were recordedby '*Kezie*' and '*Chongloiman*'which were also at par.'*Kezie*' and '*Chongloiman*' were found to exhibit superior morphological traits, which enabledefficient utilization of growth resources and ultimately resulted in better expression of crop growth and yield attributes. The higher grain yield observed under '*Chongloiman*' was due to high higher dry accumulation and number of filled grains/panicle, whereas higher grain yield associated with '*Kezie*' was due to higher number of tillers/m^2, panicles/m^2 and filled grains/panicle. The realization of high yield potential for rice was closely related to the improved sink size, such as more panicles per square meter and grains per panicle (Chen *at al.,* 2008). Rice yield is mainly dependent on producing ability of dry matter before heading (Katsura*et al.,* 2007). Grain number, which is the major part of sink size, is positively correlated with yield (Yoshida *et al.,* 2006).In case of straw yield the cultivars '*Leikhumo*' and '*Kotsala*'were at par and recorded significantly higher straw yields over the cultivar '*Kezie*' which may be due increased plant heightand higher partitioning of dry matter into vegetative parts.

Economics

Data presented in Table.3 shows that all the four cultivars *'Leikhumo'*, *'Kotsala'*, '*Kezie'*and '*Chongloiman'* recorded the highest cost of cultivation under broadcasting method, which was due to higher seed and cost of chemical required for seed treatment whereas; the lowest cost of cultivation was incurred by all the cultivars under line sowing owing to lower requirement of seeds and chemicals. The highest gross return and net return/ha and also the highest BCR (benefit cost ratio) was recorded by the cultivar '*Chongloiman'*under line sowing whereas, the lowest gross return and net return/ha and BCR was recorded by '*Leikhumo*' under broadcasting method of sowing.

CONCLUSIONS

The study revealed that '*Chongloiman*' was the superior cultivar among the four cultivars tested showing superior crop growth and higher yield potential. Whereas,between the two crop establishment methods, line sowing was found to be more effective in facilitating superior crop growth and yield of direct-seeded rice as compared to broadcasting. The cultivation method involving the cultivar 'Chongloiman' with the crop establishment method 'line sowing'was found to be the most economicallyfeasible and viable cultivation practiceproviding the highest gross return and net return/ha and also recording the highest BCRamong the treatments tested.

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APPENDICES

Table 1: Effect of Crop Establishment Methods and Cultivars on Leaf Area Index (LAI), Plant Height, Tillers, Dry Matter Accumulation and Crop Growth Rate (CGR) of Direct-Seeded Rice

Treatments	LAI (60 DAS)		Plant Height (cm)		Tillers (No./m²)		Dry Matter Accumulation (g/m²)		CGR (g/Day)			
									(0 to 30 DAS)		(30 to 60 DAS)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Planting Methods:												
Broadcasting	4.17	4.17	97.10	110.69	15.60	17.23	1069.82	1074.93	10.09	10.79	12.08	12.91
Line Sowing	5.35	5.12	135.02	128.94	18.59	19.45	1288.77	1312.65	12.53	12.21	18.34	18.45
S. Em+	0.26	0.22	8.40	3.66	0.46	0.42	44.91	45.70	0.35	0.26	1.31	1.24
LSD (P=0.05)	1.11	0.94	36.13	15.75	1.99	1.80	193.24	196.66	1.50	1.14	5.63	5.32
Cultivars:												
'Leikhumo'	4.08	3.97	126.91	130.22	16.61	17.87	1114.00	1128.07	10.61	10.75	13.07	13.76
'Kotsala'	4.53	4.57	128.09	131.94	16.40	17.76	1130.84	1145.38	11.19	11.41	14.77	15.40
'Kezie'	5.37	5.24	95.05	97.87	18.39	19.73	1176.48	1191.19	11.64	11.79	16.49	16.64
'Chongloiman'	5.05	4.80	114.18	119.22	16.97	18.00	1295.85	1310.52	11.81	12.05	16.51	16.92
S. Em+	0.30	0.30	5.71	4.79	0.58	0.44	39.64	43.92	0.30	0.35	1.24	1.06
LSD (P=0.05)	0.65	0.65	12.44	10.45	1.26	0.97	86.37	95.71	0.64	0.77	2.71	2.30

Legend:
DAS- Days after sowing
Cm- Centimeter
g- Grams
S.Em- Standard error of mean
LSD- Least significant difference

Table 2: Effect of Crop Establishment Methods and Cultivars on Number of Panicles, filled Grains, Sterility Percentage, 1000 Grain Weight, Grain Yield and Straw yield of Direct-Seeded Rice

Treatments	Panicles (No./m²)		Filled Grains (No./panicle)		Sterility Percentage (%)		1000 Grain Weight (g)		Grain Yield (q/ha)		Straw Yield (q/ha)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Planting Methods:												
Broadcasting	11.13	11.97	10.04	11.29	28.32	26.86	21.95	22.63	20.54	21.70	31.15	32.42
Line Sowing	14.60	14.29	14.16	13.18	20.38	18.36	27.45	28.12	28.61	30.00	37.14	37.49
S. Em+	0.67	0.54	0.76	0.43	3.68	2.35	1.12	1.10	1.37	0.97	1.12	1.14
LSD (P=0.05)	2.89	2.32	3.29	1.86	NS	NS	4.84	4.75	5.90	4.16	4.84	4.90
Cultivars:												
'Leikhumo'	11.83	12.17	10.74	10.99	28.78	27.82	23.83	24.48	22.03	23.70	36.69	37.63
'Kotsala'	11.80	12.09	11.52	11.71	27.25	25.74	23.92	24.55	23.56	25.35	34.77	35.34
'Kezie'	14.75	14.94	12.66	12.59	20.65	18.48	24.73	25.42	25.01	26.09	31.08	32.11
'Chongloiman'	13.07	13.32	13.49	13.67	20.73	18.40	26.32	27.05	27.70	28.27	34.05	34.75
S. Em+	0.80	0.75	0.88	0.59	2.66	2.84	1.19	1.12	1.27	1.10	1.56	1.44
LSD (P=0.05)	1.75	1.63	1.91	1.28	5.80	6.18	NS	NS	2.76	2.39	3.41	3.13

Legend:
NS - Non-significant
g - Grams
q/ha - Quintals per hectare
S.Em- Standard error of mean
LSD- Least significant difference

Table 3: Comparative Cost of Cultivation/ha, Gross Return/Ha, Net return/Ha and BCR (Benefit Cost Ratio) of the Different Cultivation Practices

Cultivation practice	Cost of Cultivation* (`/ha)	Gross Return (`/ha)		Net Return (`/ha)		Benefit Cost Ratio (%)	
		2009	2010	2009	2010	2009	2010
'*Leikhumo*' + Broadcasting	18211	23617	27294	5406	9083	1.30	1.50
'*Kotsala*' + Broadcasting	18211	26797	29264	8586	11053	1.47	1.61
'*Kezie*' + Broadcasting	18211	28695	28289	10484	10078	1.58	1.55
'*Chongloiman*' + Broadcasting	18211	31416	29749	13205	11538	1.73	1.63
'*Leikhumo*' + Line sowing	16614	33845	35022	17231	18408	2.04	2.11
'*Kotsala*' + Line sowing	16614	33653	36014	17039	19400	2.03	2.17
'*Kezie*' + Line sowing	16614	37468	38907	20846	22293	2.25	2.34
'*Chongloiman*' + Line sowing	16614	40161	42137	23547	25523	2.42	2.54

Legend:

*- Cost of cultivation was common for both the years

`/ha: Rupees per hectare